Computational modelling to predict/explain MI-BCI users' performances and their progression

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COMPUTATIONAL MODELLING TO PREDICT/EXPLAIN MI-BCI USERS' PERFORMANCES AND THEIR PROGRESSION

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Mental-Imagery based Brain-Computer Interfaces (MI-BCIs) make use of brain signals produced during mental imagery tasks to control a computerized system. The current unreliability of MI-BCIs could be due, at least in part, to the use of inappropriate user-training procedures. In order to improve these procedures, it is necessary first to understand the mechanisms underlying MI-BCI user-training, notably through the identification of the factors influencing it. Thus, we aim at creating a statistical model that could explain/predict the mean performances of MI-BCI users using their traits (e.g., personality) but also the evolution of performances using demographic data (age, gender) and the timing of the experiment (time lapse between two sessions).
We used the data of 42 participants collected from three different studies [1–3] that were based on the same MI-BCI paradigm. They were asked to learn to control an MI-BCI by performing three MI-tasks (i.e., left-hand motor imagery, mental rotation and mental subtraction) across different training sessions (3 or 6 depending on the experiment). We used a LASSO regression (Least Absolute Shrinkage and Selection Operator)[4] with a leave-one-subject-out cross validation to build different models.
Our first results showed that using the users' traits may only enable the prediction of performances within one multiple-session experiment, but might not be sufficient to reliably predict MI-BCI performances across experiments. In a second time, we were able to find a model gathering all the subjects that could predict the mean performance of a session using the participant's gender, the timing of the experiment and the mean performance over the previous session ($p < .01$).
Further studies considering, for instance, an estimation of the users' states and new metrics to assess performances are necessary to reveal more reliable models of MI-BCI performances.

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